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09/868,316	08/23/2001	Naomasa Shiraishi	109820	8919

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EXAMINER

RUGGLES, JOHN S

ART UNIT PAPER NUMBER

1756

DATE MAILED: 12/09/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.	Applicant(s)	
09/868,316	SHIRAIISHI, NAOMASA	
Examiner	Art Unit	
John Ruggles	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 16 October 2003 and 29 October 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-15 is/are pending in the application.
- 4a) Of the above claim(s) 1 and 5-15 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 2-4 is/are rejected.
- 7) ☒ Claim(s) 2-4 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 18 June 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. §§ 119 and 120

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.  
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 10292001.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

## **DETAILED ACTION**

### ***Election/Restrictions***

Applicant's election with traverse of Group II, claims 2-4, which was filed on 16 October 2003 is acknowledged. Therefore, claims 1 and 5-15 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to nonelected inventions. The traversal is on the ground(s) that applicants have chosen a different basis for special technical features than those set forth in the restriction requirement mailed out on 16 September 2003. This is not found persuasive because applicants have failed to adequately rebut those set forth by the examiner. Merely stating preference for a different basis is not sufficiently responsive to cause reversal of this restriction requirement.

The requirement is still deemed proper and is therefore made FINAL.

### ***Priority***

Applicant cannot rely upon the foreign priority papers to overcome this rejection because a translation of said papers has not been made of record in accordance with 37 CFR 1.55. See MPEP § 201.15.

### ***Information Disclosure Statement***

The listing of references in the specification (e.g., at lines 12-13 on page 8 of the preliminary amendment filed 23 August 2001 that replaces the list at line 3 on page 39 of the original specification, etc.) is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the

Office, and MPEP § 609 A (1) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have either been submitted by applicant as a list in a separate paper (e.g., PTO-1449, etc.) or cited by the examiner on form PTO-892, they have not been considered.

### *Specification*

35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is replete with terms, which are not clear, concise and exact. The specification should be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some unclear, inexact or verbose terms used in the specification are: (1) in line 3 on page 2, --laser-- has been misspelled (emphasis added); (2) in lines 5 and 16, also on page 2, "remained resist" should be --remaining resist-- and "than precision" should be changed to --than the precision--, respectively, both to be grammatically correct; and (3) in lines 1 and 2 on page 3, --wavelength-- and --defined--, respectively, have also both been misspelled (again, emphasis added). Note that due to the number of errors, those listed here are merely examples of the corrections needed and do not represent an exhaustive list thereof.

Appropriate correction is required. A statement that it contains no new matter must accompany an amendment filed making all appropriate corrections.

### *Claim Objections*

Claims 2-4 are objected to because of the following informalities: "A producing method of a photomask" should be changed to --A method of producing a photomask-- in the first line of

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each of these claims, to be grammatically correct. Claims 3-4 are dependent on claim 2.

Appropriate correction is required.

***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 2-4 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Lines 1-3 of claim 2 seem to require that the "first illumination condition" only be applied for intended use of the photomask in subsequent lithography, rather than for use during the first step of forming the master mask prior to forming the photomask. However, lines 7-8 of claim 2 require "a second illumination condition set such as to compensate a variation in a projection image under the first illumination condition". This means that the first illumination condition must have been used in the first step enlarging of a pattern to form the master mask. Accordingly, for the purpose of this Office action and in order to advance the prosecution of this application, the first illumination condition is interpreted as used during the first step enlarging to make the master mask. Even so, claim 2 must still be amended to clarify how and when the first illumination condition limitation is used in this process of making the photomask. Claims 3-4 are dependent on claim 2.

Also in claim 2, it is unclear whether the first step of "forming a parent pattern obtained by enlarging the pattern on a first substrate, thereby forming a master mask" means (1) enlarging

a pattern on a first substrate to form a parent pattern on a master mask or (2) enlarging a parent pattern on a first substrate to form a master mask. For the purpose of this Office action and in order to advance the prosecution of this application, this first step in claim 2 is interpreted in accordance with the first interpretation (1) above, to mean --enlarging a pattern on a first substrate to form a parent pattern on a master mask--. However, applicant must still amend claim 2 in order to clarify the meaning of this first step. Claims 3-4 are dependent on claim 2.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 2-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hashimoto et al. (US Patent 6,048,648) in view of Pierrat (US Patent 6,218,089).

Hashimoto teaches a patterned photomask including an optical shield layer having variable light transmittance and a method of patterning a semiconductor device by photolithographic reduction exposure of a semiconductor substrate through the patterned photomask. The same photolithographic process was also applicable to transfer of a pattern on a reticle or master mask in place of the patterned photomask for producing a patterned photomask instead of a semiconductor device (column 1, lines 1-10 and column 5, lines 41-43). Figure 1 shows a prior art photomask having a patterned chromium (Cr) layer optical shield layer 102.

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This photomask has a fine, closely spaced line pattern 102a in region  $R_1$  and a course, isolated line pattern 102b in region  $R_2$ . The width of each line and space are the same in the fine pattern 102a. In the isolated pattern 102b, the linewidth is the same as the linewidth of the fine pattern 102a. Using a light source coherence of  $\sigma = 0.7$  for a reduction exposure through this prior art Cr patterned photomask of a resist layer 104, the fine pattern 102a was transferred to form imaged lines and spaces having the same width (about  $0.25 \mu\text{m}$ ) in the resist 104. But, the isolated line pattern 102b was transferred to form a wider imaged line width (about  $0.28 \mu\text{m}$ ). This proportional widening of isolated lines as compared to those in the fine pattern region (about  $0.03 \mu\text{m}$ , which corresponds to a difference of greater than 10 %) is called the optical proximity effect and is shown by the light strength distribution diagram of Figure 2 (column 2, lines 24-63). Hashimoto compensates for the optical proximity effect by replacing the opaque Cr isolated line pattern region 102b of the prior art photomask with molybdenum silicon (MoSi) 1021, which is translucent, to form a partially transparent pattern region 102b', as shown in Figure 8. After reduction exposure through the modified photomask using the same light source coherence of  $\sigma = 0.7$ , the resulting imaged pattern had isolated pattern and fine pattern regions  $R_1$  and  $R_2$  with the same line width (about  $0.25 \mu\text{m}$ ), as shown in the light strength distribution diagram of Figure 9 (column 4, lines 1-23). If the illumination condition is changed to cause the fine pattern region line width to be greater than the isolated pattern line width using a prior art patterned Cr photomask, then the optical proximity effect could be compensated for by replacing the Cr fine line pattern region of the photomask with the MoSi partially transparent material (column 4, lines 24-40). This suggests that changing an illumination parameter (e.g., lower

coherence, etc.) could also assist in compensating for the optical proximity effect, even without changing the photomask pattern material.

While (1) recognizing and compensating for the optical proximity effect that causes different imaged line widths for fine and isolated pattern regions on a photomask produced by transfer of a pattern from a master mask by selectively changing the pattern material on the master mask and (2) even acknowledging an effect of illumination conditions on the optical proximity effect that causes imaged line width differences transferred from a master mask, Hashimoto does not specifically teach plural successive exposures at different illumination conditions (e.g., coherence, etc.) to intentionally compensate for the optical proximity effect.

Pierrat teaches a photolithographic method for reducing or eliminating the optical proximity effect by multiple exposures of the desired pattern under different optical conditions (abstract). This method of compensating for optical proximity effects is applicable to many forms of photolithography (e.g., laser or non-laser deep UV, x-ray, etc., column 5, lines 28-34). The optical proximity effect causes differences of about 15 % in the relative imaged line widths of isolated and densely packed lines, as shown in Figures 1 and 3 (column 5, line 35 to column 6, line 36). The optical conditions that are considered beneficial in compensating for this optical proximity effect include (1) changing the axis of exposure and (2) changing the illumination coherence. Off-axis exposure (provided by adding a plate shaped to selectively block radiation emanating from the center of the radiation source, which is considered to read on the alternative circular zone plate illumination recited in instant claims 3 and 4) causes the width of densely packed lines in region 32 to be about 15 % greater than the width of isolated lines in region 34, shown in Figure 4. Thus, a first on-axis exposure of Figure 3 at a 50 % dosage followed by a



second 50 % dosage using the off-axis exposure of Figure 4 yielded equal and opposite optical proximity effects, resulting in essentially the same combined relative line widths for both isolated and densely packed regions in the imaged pattern (column 6, line 37 to column 7, line 13). Similarly, two 50 % dosage exposures of the same mask pattern, the first at  $\sigma = 0.7$  and the second at  $\sigma = 0.5$ , resulted in reducing the difference in line widths between isolated and densely packed regions of the overall imaged pattern from 15 % (for a single exposure) to about 3 % (for the double exposure at different coherencies) as described at column 7, lines 14-36.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have substituted the plural exposure method using different illumination conditions for each exposure (e.g., varying the axis of exposure or the illumination coherence, etc.) to compensate for optical proximity effects as taught by Pierrat in the method of producing a photomask by transferring a master mask pattern as taught and suggested by Hashimoto. This is because (1) both references are directed to the same art of reducing or eliminating optical proximity effects that cause differences in line widths of isolated and densely packed regions during photolithographic imaging and (2) Hashimoto acknowledges the ability of optical illumination conditions to reverse the optical proximity effect in line width difference between isolated and densely packed regions of an imaged photomask produced by transferring a parent pattern from a master mask (instant claim 2). Furthermore, Pierrat's showing that reducing the coherence from  $\sigma = 0.7$  in the first exposure (reads on the instant  $\sigma \geq 0.7$ ) to  $\sigma = 0.5$  in the second exposure did not fully compensate for the optical proximity effect that caused the imaged isolated line width to be greater than the imaged densely packed line width suggests that further reduction in the coherence during the second exposure (extrapolation to double the reduction in

coherence to  $\sigma \sim 0.3$  would clearly read on the instant coherence range of  $0.1 \leq \sigma \leq 0.4$ , instant claim 3) would be expected to result in further reduction in the imaged isolated line width relative to that of the imaged densely packed line width, possibly further reducing the overall optical proximity effect. Also, the combined overall effect of plural exposures at different illumination conditions (each causing opposite optical proximity effects on the relative line width of isolated and densely packed pattern regions) would be expected to result in the same overall reduction of these effects, regardless of the order in which the exposures under different illumination conditions are performed (instant claim 4).

As a further extension of this combined concept, addition of (1) another exposure step at a third different illumination condition and/or (2) enlargement at an illumination condition that may be the same as either of the first or second illumination conditions (e.g., by prior imaging to form a parent pattern on the master mask from an original pattern on a substrate, etc.) would have been obvious to one of ordinary skill in the art to further correct for the difference in line widths between isolated and densely packed regions of the original pattern in order to further compensate for optical proximity effects (instant claims 2-4).

### *Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9310.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.



John Ruggles

Examiner

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